Information on thunderstorm initiation, nowcast, and forecast for aviation safety and efficiency

by Dennis Stich,
C. Forster, A. Tafferner, M. Köhler, I. Sölch, and T. Gerz

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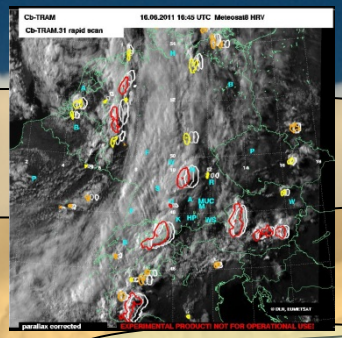
DLR

Thunderstorm information for air traffic - why?

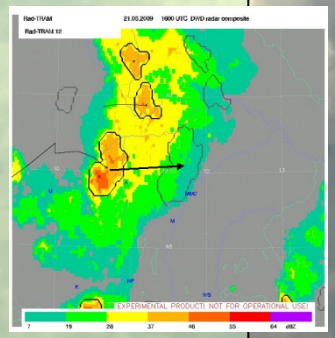
- Adverse weather is responsible for 40-50% of all delays in Europe
- Thunderstorm activity is the reason for up to 90 % of all delays in the airspace over the USA during the summer months.
- Up to 96% of all delays at Munich Airport are due to adverse weather with thunderstorms and fog as the primary reasons

Thunderstrom information for aviation is still rudimentary these days!

Thunderstorms as weatherobjects with multiple object attributes



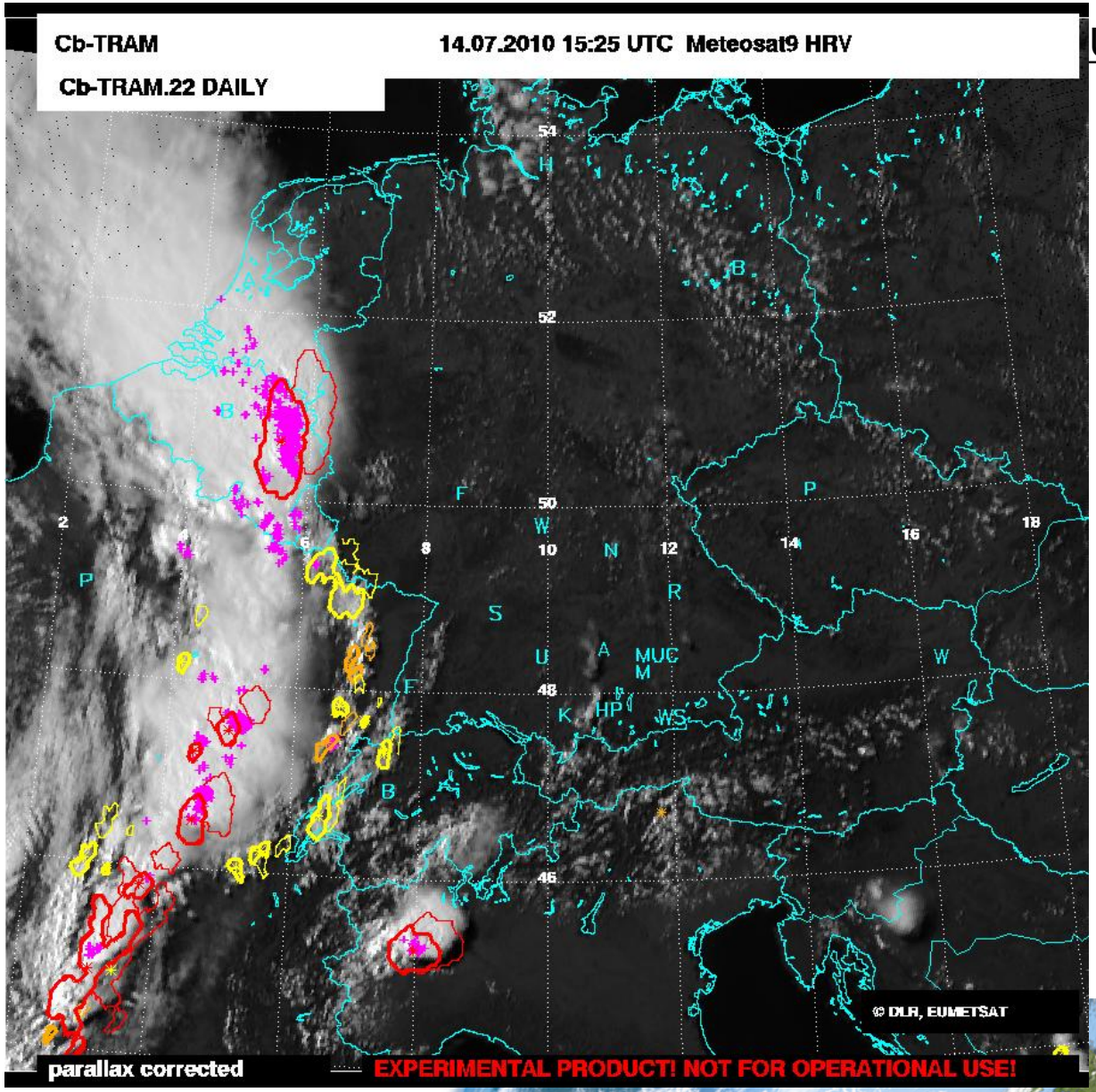
Cb top:
conv. turbulence,
lightning activity, etc.
detected by satellite
(Cb-TRAM)



Cb bottom:
hail, icing, lightning, heavy rain,
turbulence, etc.
detected by radar
(Rad-TRAM)

Picture by Martin Köhler, DLR

Cb-TRAM - Cumulonimbus TRacking And Monitoring



Used MSG (rapidscan) data:

WV 6.2	IR 10.8
IR 12.0	HRV

Detection stages:

1: Convection Initiation (CI)
- development in HRV
- IR 10.8 cooling

2: Rapid development
- WV 6.2 rapid cooling (> 1K/15min)

3: Mature storms
- T 6.2 - T 10.8
- HRV texture

Lightning (LINET)

Extrapolation up to 60 min
(here 30 minute nowcast plotted)

Description: Zinner et al., 2008,09 & 13

CI postprocessing with additional data

LINET data & ingredients describing moisture, instability, and lift
(equivalent potential temperature θ_e, **KO-Index**, vertical motion **ω in 500 hPA)**

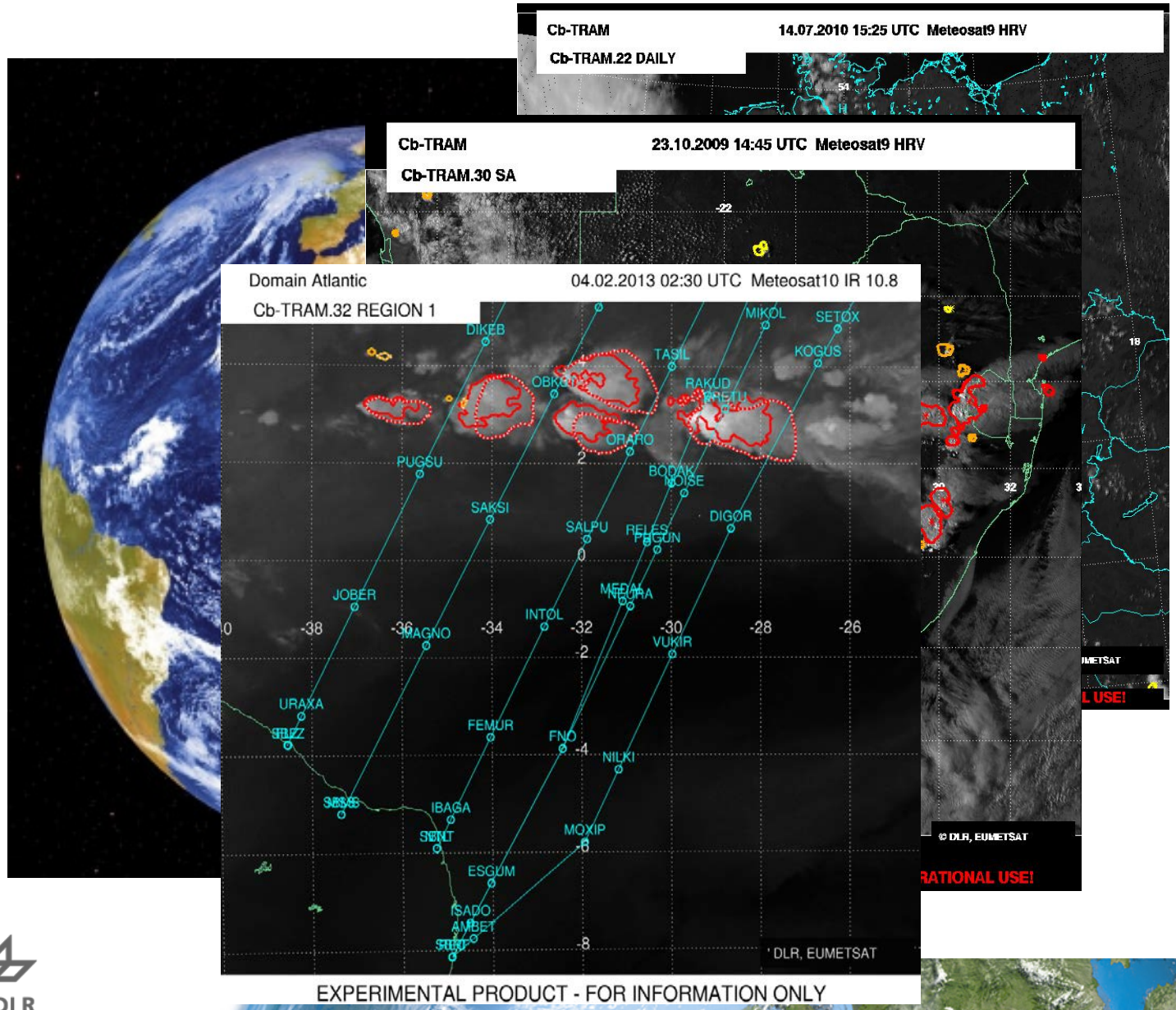
Generation of a **CI forcing** value for each CI detection with fuzzy logic

CI forcing values can be translated into a statistical **probability of further development**

Lowest probabilities can be filtered

The **probability of further development** is an additional information which can be treated as a kind of confidence level assigned to the CI detection

Cb-TRAM: area of application



first successful data link tests
cooperation DLR - DLH

Foto: Capt. Andreas Borengässer (Lufthansa Cityline)

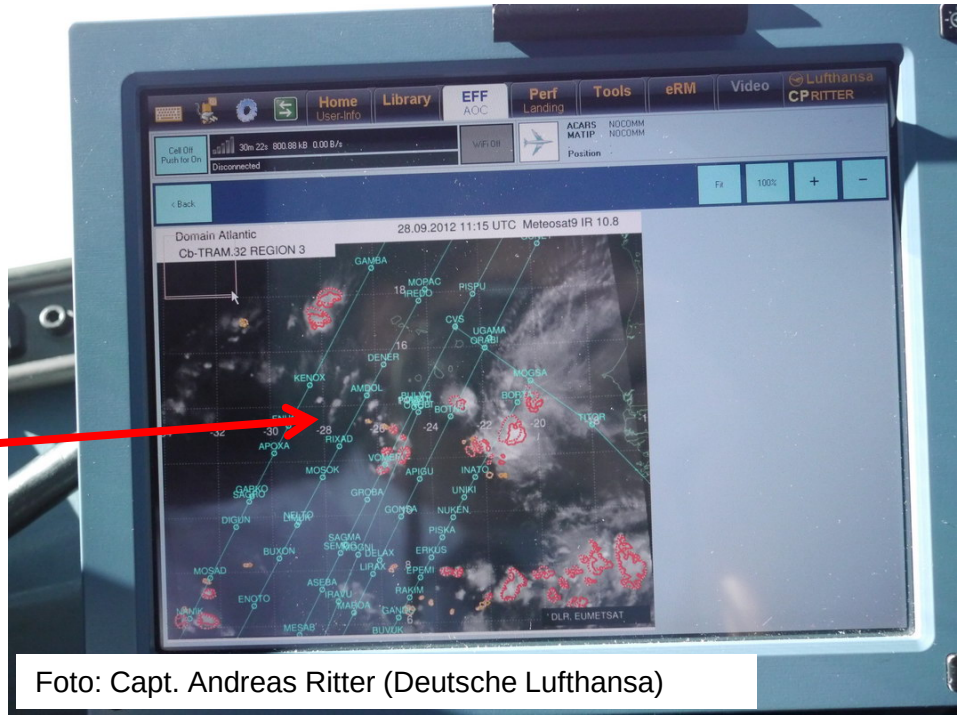


Foto: Capt. Andreas Ritter (Deutsche Lufthansa)

Lufthansa GADCom project (Ground Air Data Link Communication):

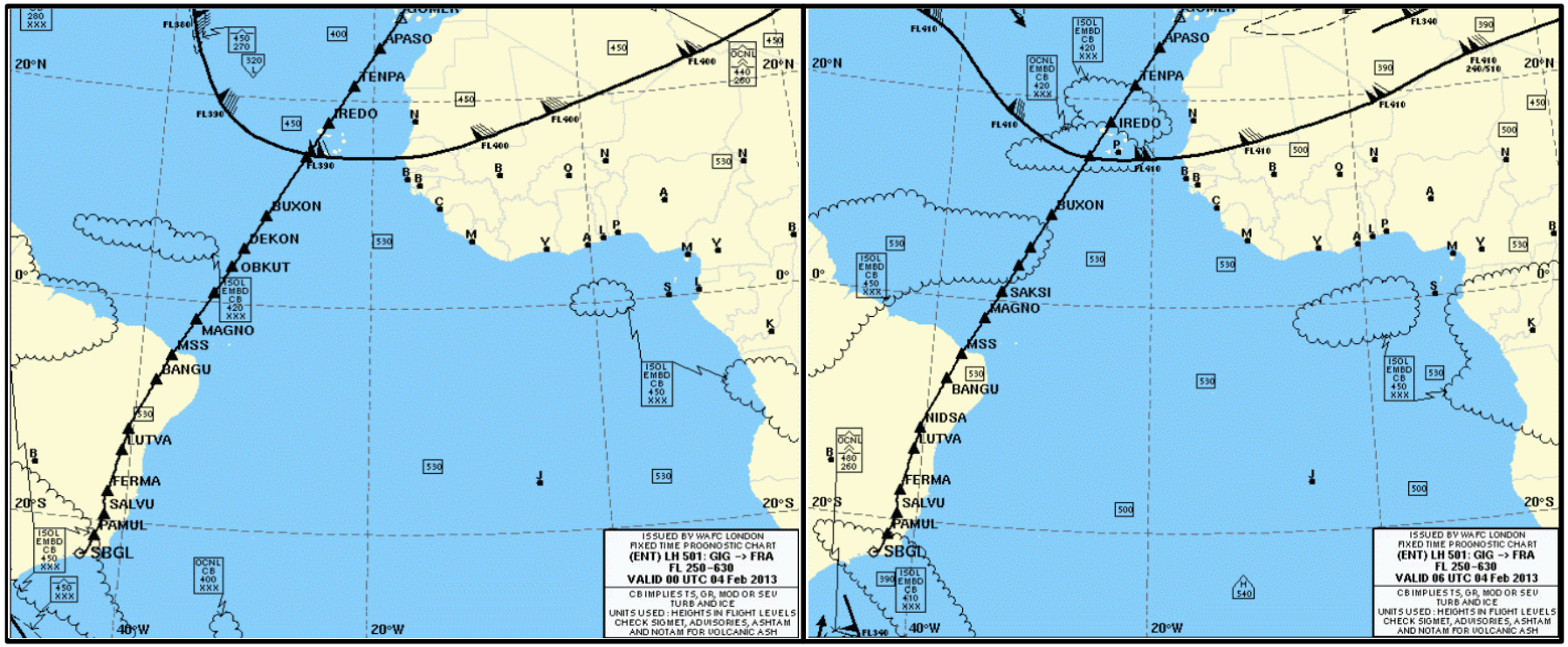
GADCom Lufthansa

Real time link of Rad-TRAM and Cb-TRAM data in 5 EFBs (Electronic Flight Bags) of Lufthansa Cityline aircraft via mobile network on the ground and later in 5 EFBs of Lufthansa aircraft via FlyNet during cruise-flight

DLR

The Test Flight: Rio de Janeiro to Frankfurt, February 2013

According to the charts: Business as usual at the ITCZ

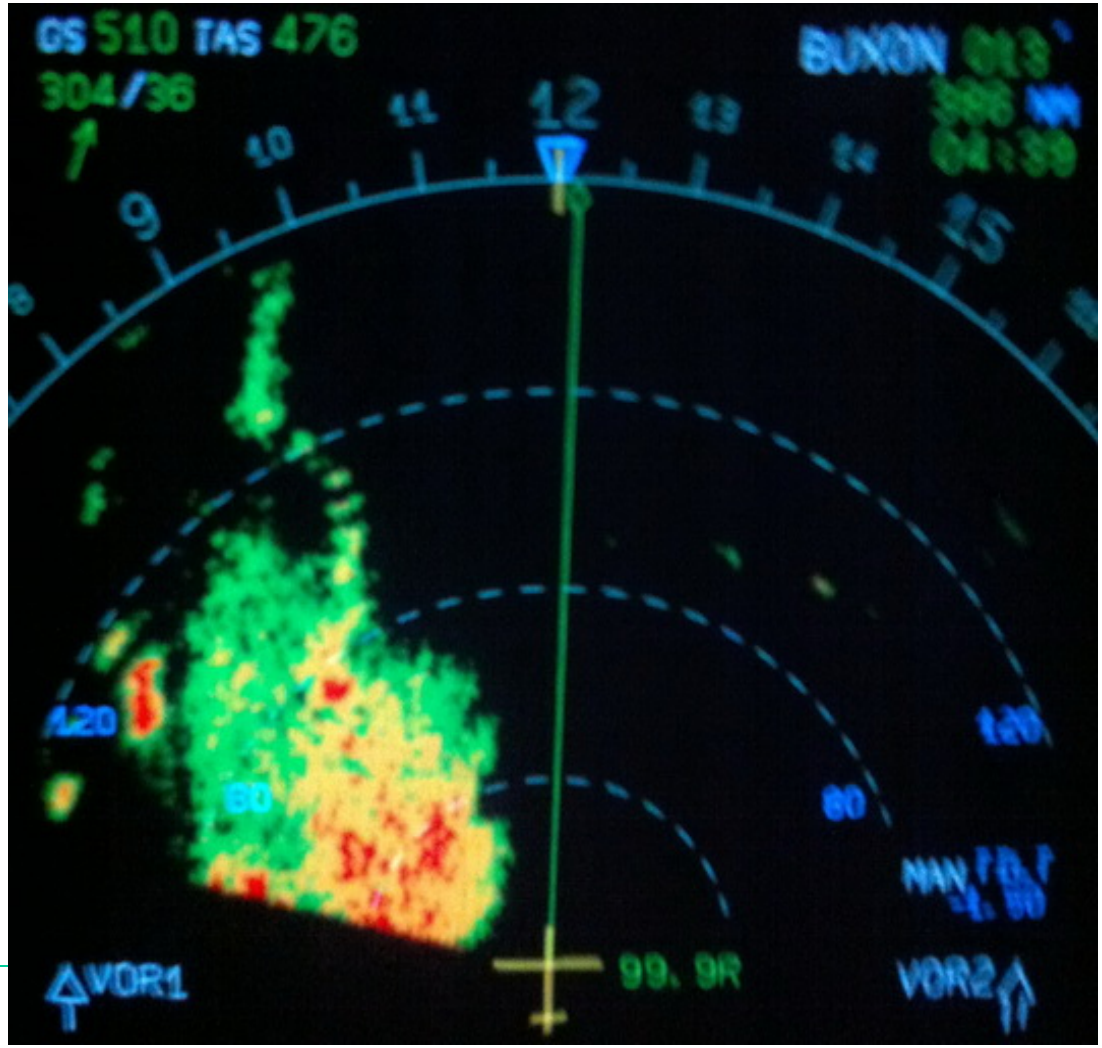


courtesy of A. Ritter, DLH

The Test Flight: Rio de Janeiro to Frankfurt, February 2013

But once we got there, the weather radar showed large red cells, embedded in amber

Initially without the help of Cb-TRAM, the crew decided to deviate 90 degrees to the right

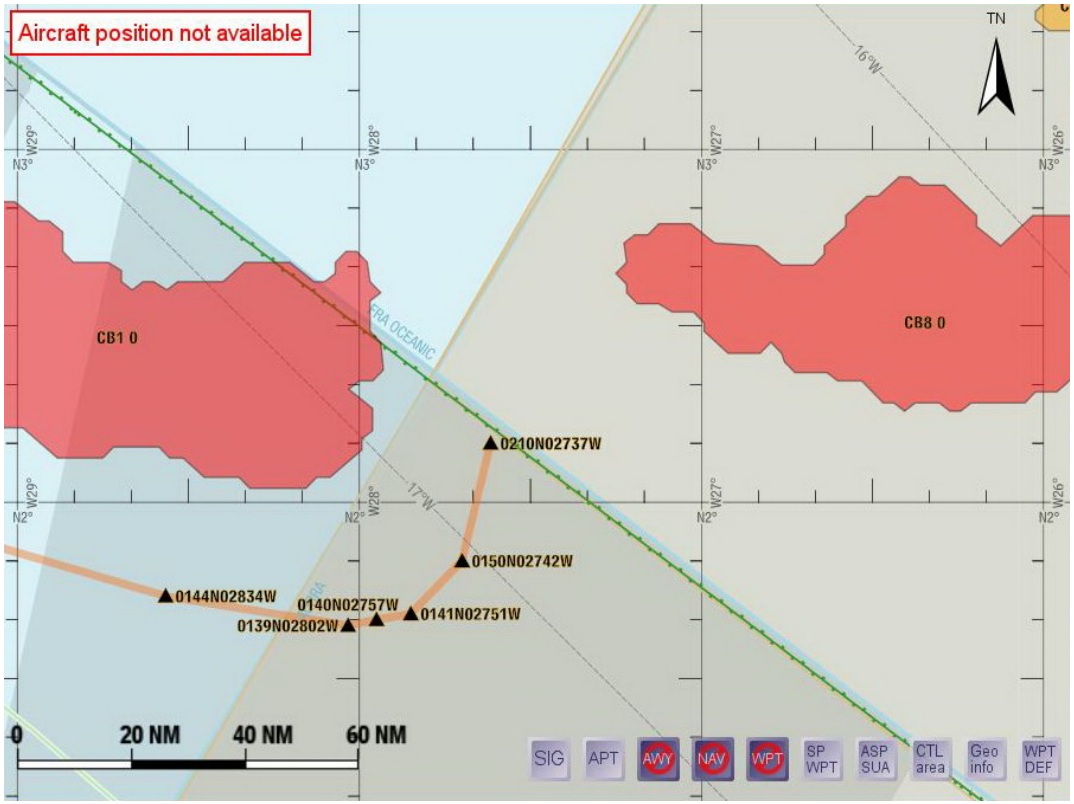


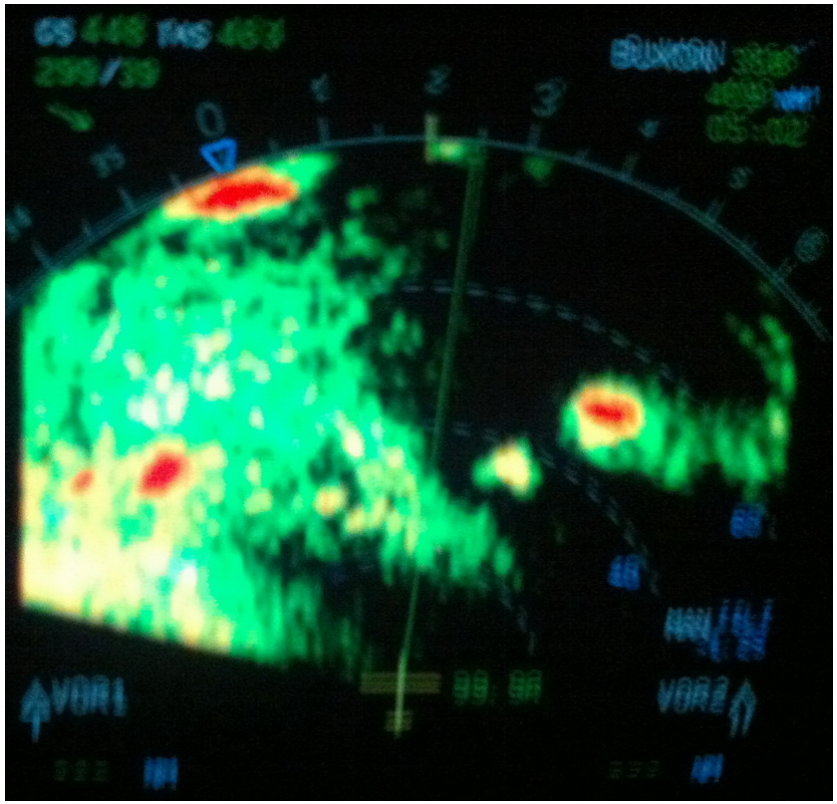
courtesy of A. Ritter, DLH

Then, we uplinked the latest Cb-TRAMs to the eRM …

... planned the safest route with the eRM ...

... and flew it tactically by looking at the weather radar

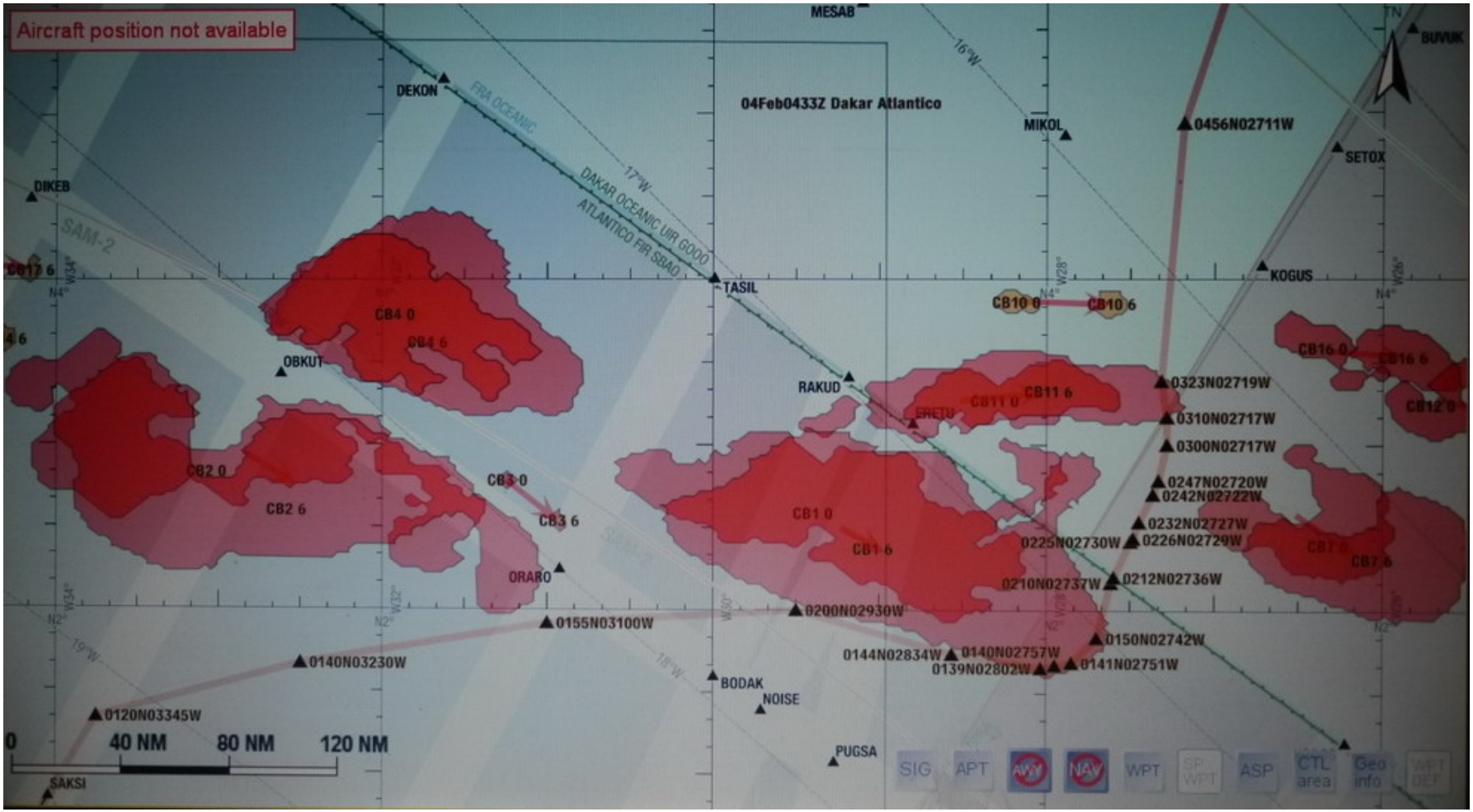




GEDCom Lufthansa DLR

after A. Ritter, DLH

The result

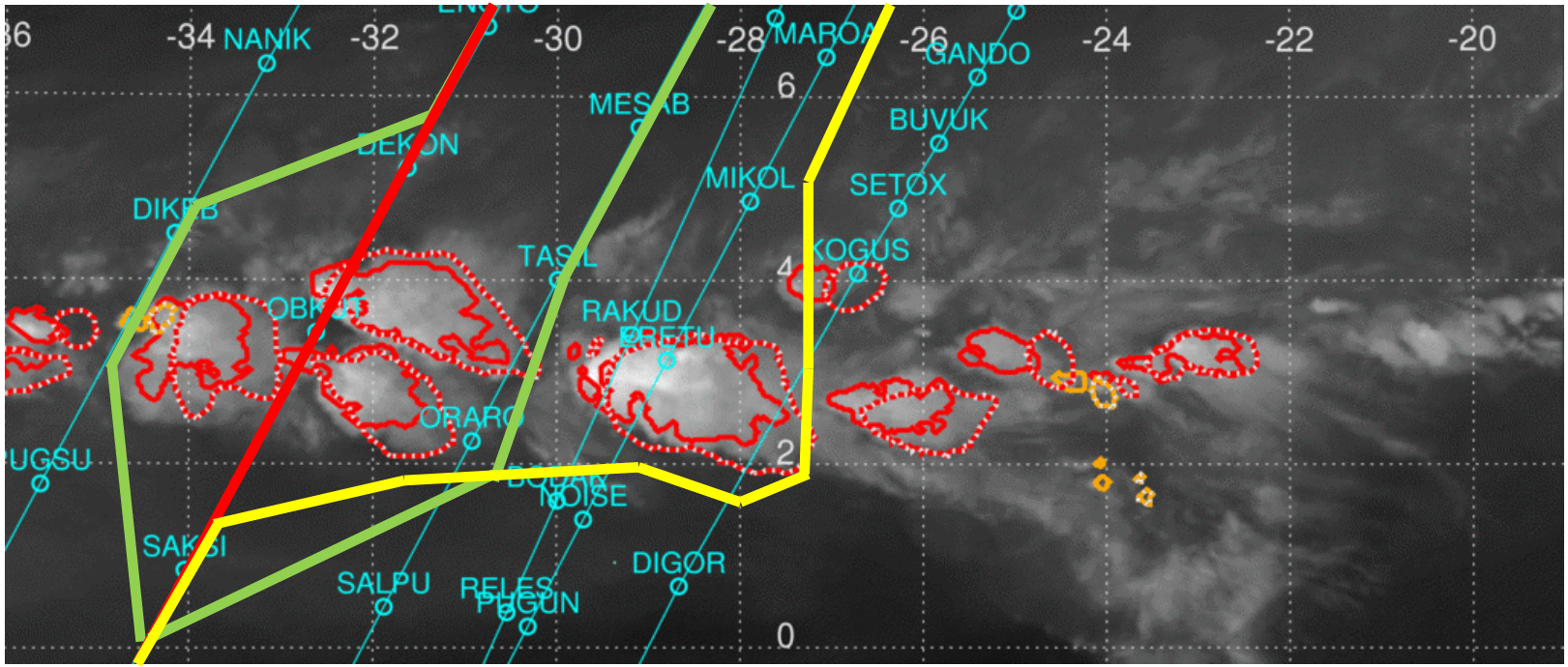


courtesy of A. Ritter, DLH

If we would have uplinked the Cb-TRAM a few minutes earlier ….

… we would have seen the gap on the PUGSU DIKEB route

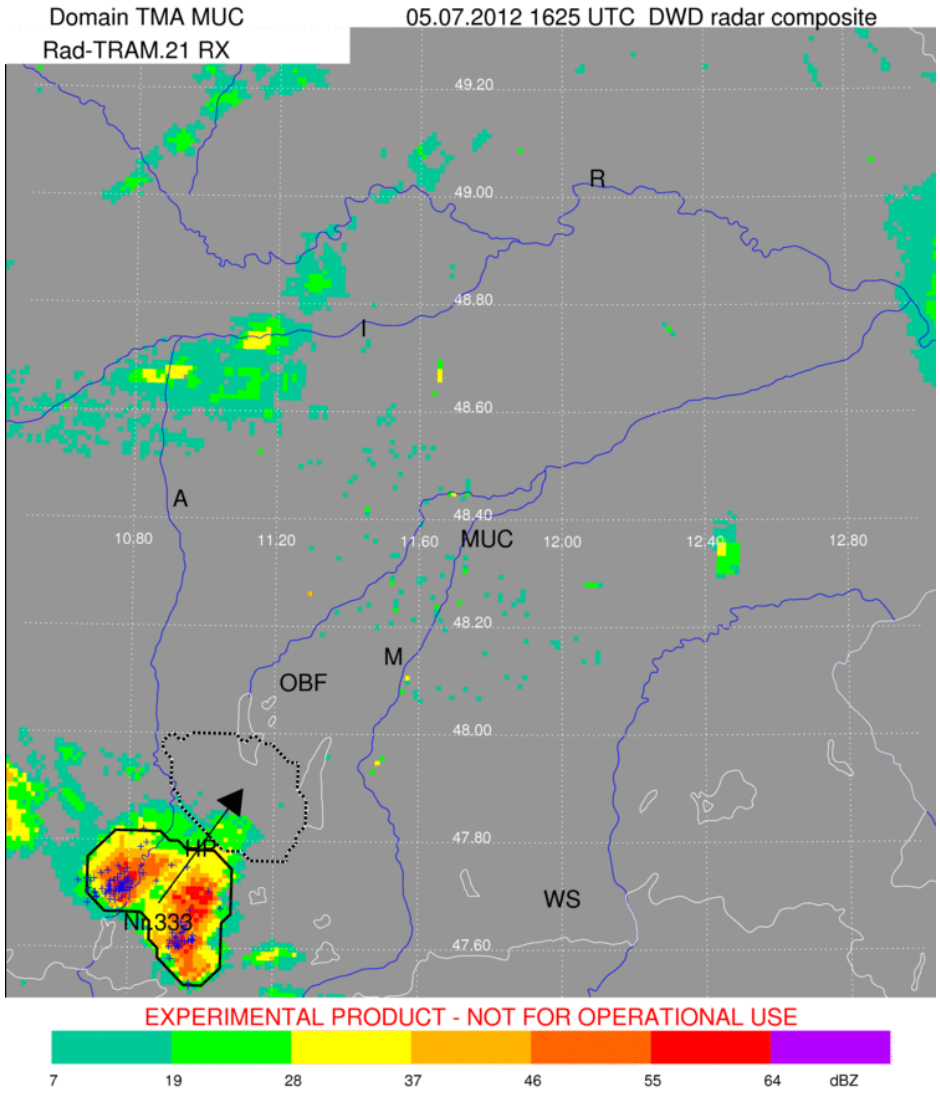
… or the gap on the ORARO-TASIL route



… and could have avoided a 300 NM deviation

courtesy of A. Ritter, DLH

Rad-TRAM - Radar Tracking and Monitoring



Based on DWD radar data:
RX and EURADCOM

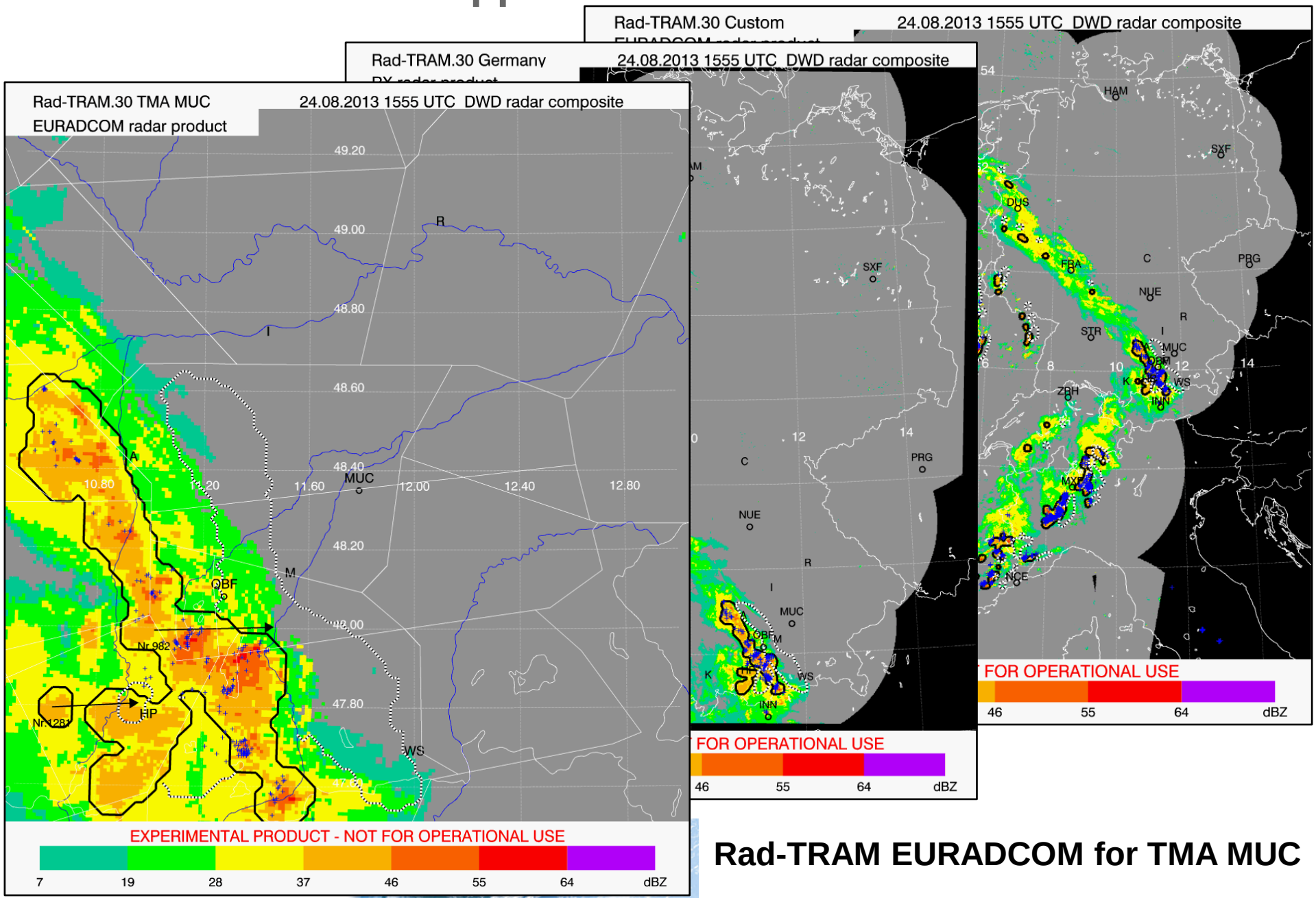
Black contours:
areas > 37 dBZ

Dotted contours:
60 min nowcast

Tracking and nowcasting based on pyramidal matching like in Cb-TRAM

Available every 5th minute

Rad-TRAM: area of application



Rad-TRAM EURADCOM for TMA MUC

Automated thunderstorm warnings (AutoAlert)

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Es

Ge
Flu

Aims:

Raise situational awareness

Presentation of the same information to describe the current situation to all stakeholders at an airport to support CDM

Weitere Gewitterzellen weniger als 100 km von MUC entfernt. Betroffene Bereiche: NW, SW, SE

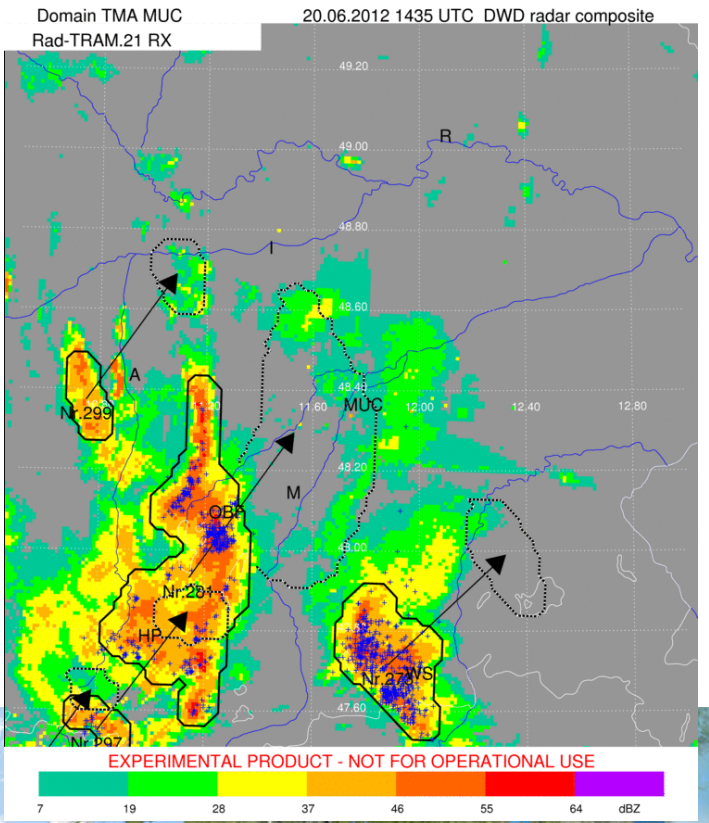
Mittlere Zugrichtung aller Zellen: nord-oestlich

Zur Erläuterung:
Gewitterzellen sind schwarz umrandet (Bereich mit Starkniederschlag).
Die Verlagerung nach 60 Minuten ist mit einem Pfeil
und einer schwarz-weiß gestrichelten Linie markiert.
Blitze (LINET) sind mit blauen Kreuzen markiert.

Weitere Informationen:
Siehe Anhang, MetFROG und http://www.pa.op.dlr.de/nowcasting/
(User: nowcasting, Passwd: drizzle)

Mit freundlichen Grüßen,
das Gewitterteam des DLR Instituts für Physik der Atmosphäre

Feedback, Fragen und Anregungen bitte an
cb-team@dlr.de Tel.: 08153 28 3174 oder 01853 28 1218

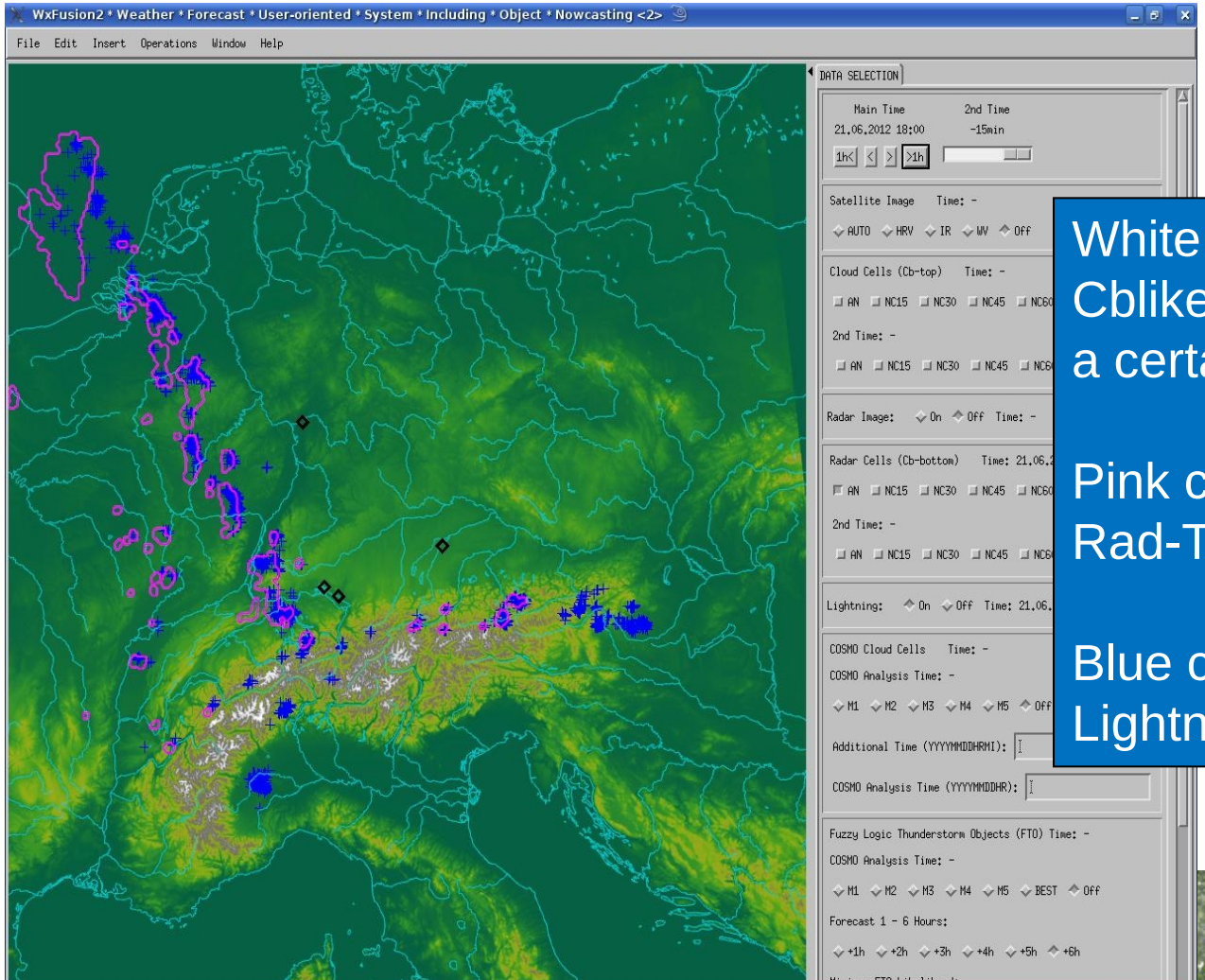


Cb indicator forecasts up to 6 hrs (Cblike)

Fuzzy logic combination of CAPE, 500 hPa vertical velocity, synthetic satellite and radar data from the DWD COSMO-DE model

Cblike observation for 21 June 2012 18:00 UTC

Cblike 6 hrs forecast for 21 June 2012 18:00 UTC



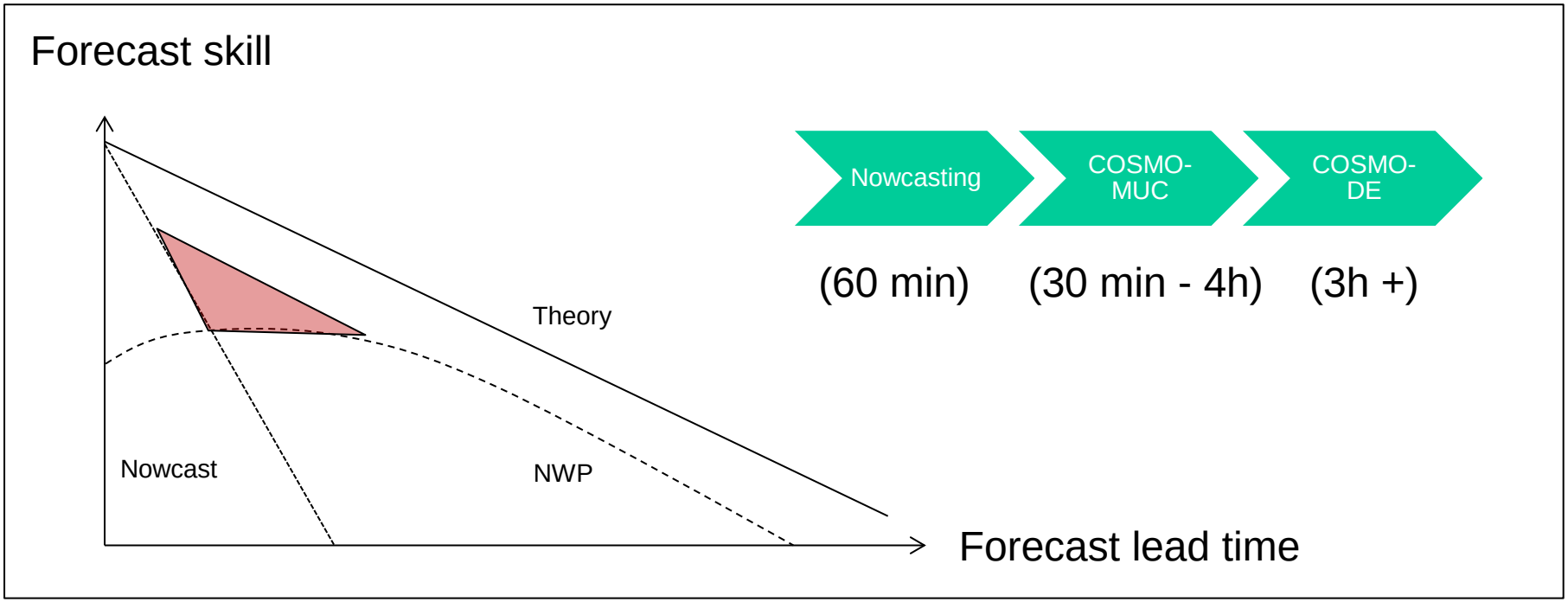
White contours:
Cblike indicator exceeding a certain threshold

Pink contours:
Rad-TRAM cells

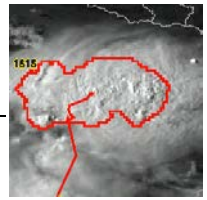
Blue crosses:
Lightning data (LINET)

Short-range limited area NWP (COSMO-MUC)

For seemless prediction of airtraffic relevant phenomena



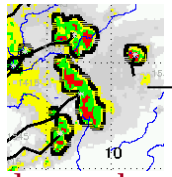
WxFUSION Weather Forecast User-oriented System Including Object Nowcasting


Cloud tracker


POLDIRAD


Lightning

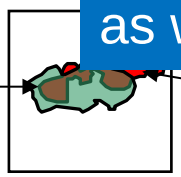
Surface Analysis

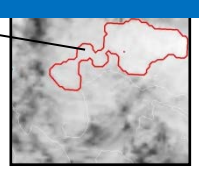

Radar tracker

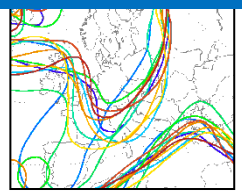
Combination of data sources through ***fuzzy logic:***

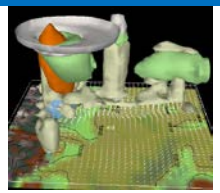
Decision finding technique allowing for parameter ranges instead of fixed thresholds

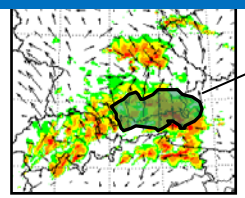
Takes into account the meteorological experience and concepts as well as local effects


Object Comparison


SYNSAT


COSMO-DE & Ensemble


Local forecasting


SYNRAD

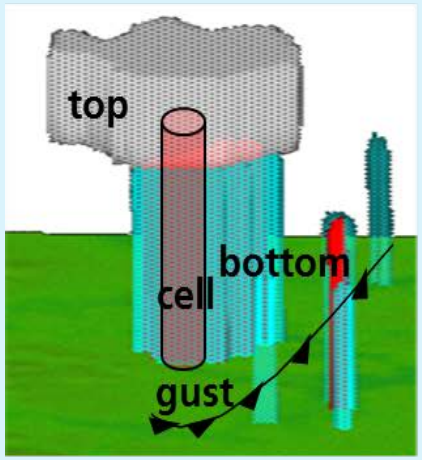

Object Comparison

Thank you for your attention!

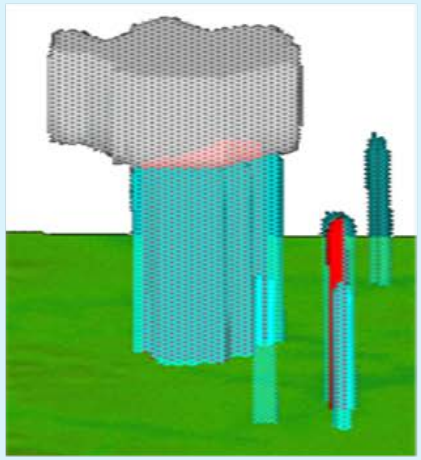
contact: dennis.stich@dlr.de

Decrease of information detail over forecast time

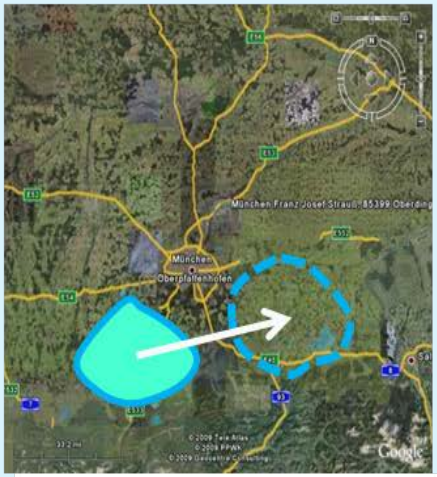
Forecast time



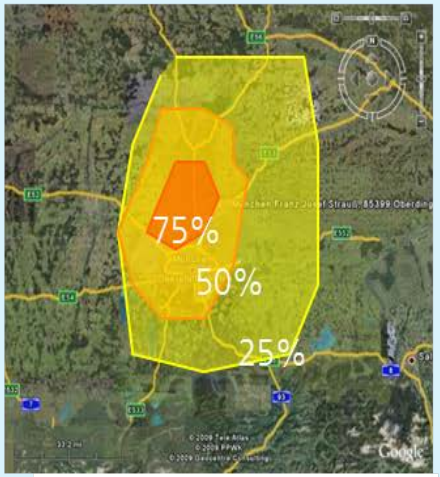
1 Analysis



2 Nowcast < 30 min



3 Nowcast 30-60 min



4 Nowcast > 60 min